**Addendum to the Wild Winter Steelhead Biological Assessment –
Response to NOAA Fisheries Request for Additional Information
November 2, 2004**

Background

On January 2, 2004, WDFW and ODFW requested re-initiation of consultation with NOAA Fisheries regarding the "Biological Opinion – Impacts of the Interim Management Agreement for Upriver Spring Chinook, Summer Chinook, and Sockeye on Salmon and Steelhead Listed under the Endangered Species Act". As part of the consultation, WDFW and ODFW prepared an updated Biological Assessment of the impacts of the fisheries on the listed species. In the Biological Assessment, WDFW and ODFW proposed that NOAA Fisheries give the states greater flexibility to manage impact rates for wild winter steelhead in the Columbia River non-Indian fisheries. Based on their analyses, the states asked NOAA Fisheries to allow impact rates up to 7% in 2004 and 2005.

After the states submitted the Biological Assessment, NOAA Fisheries, in a letter dated January 22, 2004, requested further clarification and information. In response to this request the states prepared a revised Biological Assessment that included an impact rate of up to 6% for 2004 and 2005, which was submitted on February 13, 2004. However, NOAA Fisheries had outstanding questions that remain the subject of current discussions between it and the states.

The 2004 fishery has since concluded without the need for or use of an increased impact rate. Therefore, the Biological Assessment now only applies to the 2005 fishing season. The states remain confident that, for 2005, an impact rate of up to 6% would not pose jeopardy to ESA-listed winter steelhead in the Mid-Columbia, Lower Columbia and Willamette ESUs, but would provide the needed flexibility to manage mainstem non-Indian fisheries. Any decision to manage the fishery to an impact rate greater than the current 2% would require further policy review by the states. A no-jeopardy determination, however, would provide the states with increased flexibility in determining fishery options.

In their discussions with NOAA Fisheries on the Biological Assessment, the states formed a work group of WDFW and ODFW staff that included harvest managers, steelhead biologists, and population biologists. NOAA Fisheries staff has attended the work group meetings. The work group was formed primarily to respond to questions and issues regarding the management of wild winter steelhead in the Lower Columbia River commercial fishery as proposed under the current consultation; however, it is expected that the group will continue to meet periodically to discuss the best management practices for winter steelhead in all fishery and escapement areas.

Currently, the work group is addressing a list of questions and issues brought forward by NOAA Fisheries under the current consultation and by the states through the course of work group discussions. The questions and issues are:

1) **ESU/Population Status.**
   a) Abundance
   b) Productivity
   c) Weak ESUs/Populations
      i) How should weak ESUs/populations be taken into consideration when doing a risk assessment on harvest impacts?
      ii) Could a risk assessment for individual wild populations be developed? Are the necessary data available in order to conduct the risk assessment?
      iii) How will this work with a sliding scale harvest rate for future fisheries?

2) **Run timing and variable vulnerability of ESUs and populations to fishery impacts.**
   a) Run timing differences among populations are evident in the tributaries but do they occur and can they be measured in the mainstem where the commercial fishing occurs?
   b) Can we determine what percent of the different populations are present during the commercial fishery?

3) **Pre-season run size forecasts and in-season run updates.**
   a) Can a dependable forecast method be developed?
   b) Can forecasts be produced for individual tributaries?
   c) Can in-season updates be made?

4) **Monitoring and Evaluating the Fisheries.**
   a) What is the best method for estimating catch/handle in the fishery?
   b) Can a monitoring plan be modified to improve the accuracy of catch estimates?
   c) Should catch be stratified by area or time?
   d) What is the appropriate method for calculating confidence intervals?
   e) Is multiple handle an issue?

5) **Estimating Impacts for individual ESUs.**
   a) Is there evidence that impacts differ among ESUs?
   b) Is it possible to estimate impacts by ESU and what are the constraints?

6) **Zone 6 fishery impacts on winter steelhead.**
   a) What is the status of the populations above Bonneville Dam?
   b) Are the populations above Bonneville Dam impacted at a higher rate because of the treaty fishery?

7) **Summer Steelhead.**
   a) Is there a way to estimate the contribution of summer steelhead in the fishery?

b) What is the proportion of steelhead in the mainstem that are summer steelhead during the period of the fishery? Currently the estimate ranges from 5% to 25% over time. Are these values appropriate?

This document is WDFW's and ODFW's response to these issues and questions. Each response is addressed and described in detail in the sections below.

1. Population Status

The states already provided some review of the status of wild winter steelhead in the Willamette and Lower Columbia ESUs. Monitoring of wild winter steelhead is variable in the listed ESUs. Extremely precise dam or weir counts occur in some areas, redd counts occur in other areas, but some basins, particularly smaller tributaries, are unmonitored (Table 1). Smolt counts and information about age structure are also available for some basins. Although not all systems are monitored for abundance, the available data was expanded to produce a total population estimate. The *U.S. v Oregon* TAC estimated that about 84% of the total wild winter steelhead return was accounted for in redd surveys or dam/weir counts in 2002, about 86% in 2003 and about 80% in 2004. These expansions were used by the states in impact assessment and run accountability for the three years. ODFW also expanded the Oregon populations in the listed ESUs (see Table 5, below) and estimated that 100% of the Willamette ESU, 76% of the Lower Columbia ESU and 0-5% of both the SW Washington ESU and the Mid-Columbia ESU were being monitored in Oregon. The following information updates and summarizes the status of wild winter steelhead in the Columbia Basin.

Table 1. Methods used to monitor wild winter steelhead in the Columbia Basin.

ESU	Tributary	Adult Monitoring Method
Southwest Washington (Not listed)	Chinook/Deep	No survey
	Grays	Redd counts
	Skamokawa	Redd counts
	Elochoman	Redd counts
	Mill Ck.	No survey
	Abernathy Ck	Redd counts
	Germany Ck	Redd counts
	Coal Ck	No survey
	Youngs Bay tributaries	No survey
	Bear Ck	No survey
	Big Ck	Weir Counts
	Clatskanie	No survey
	Other Oregon tributaries	No survey
Lower Columbia	Cowlitz	Dam and partial index redd counts
	Coweeman	Redd counts
	SF Toutle	Redd counts
	Green River	Index redd counts
	NF Toutle River	Trap counts
	Kalama	Redd and weir counts
	Cedar Ck (NF Lewis)	Trap
	EF Lewis	Redd counts
	Salmon Ck	No survey
	Washougal (mainstem only)	Redd counts
	Hamilton Ck	No survey
	Scappoose	Weir counts
	Clackamas	Dam counts
	Sandy	Dam counts
	Oregon Columbia Gorge	No survey
	Wind River	Redd counts/trap
	Hood River	Dam counts
Willamette	Overall ESU	Dam counts
	Individual Populations	Partial Weir and redd counts
Mid-Columbia	Oregon tributaries	No survey
	Washington tributaries	No survey

Willamette ESU abundance trends and productivity: The recent five-year average abundance of wild winter steelhead in the total Willamette ESU measured at Willamette Falls has been about 10,500 fish (2000-2004) (Table 2). The ESU as a whole increased dramatically since the mid-1990s (Figure 1). Individual populations in the Willamette are monitored by a combination of weir and redd counts that are expanded to a tributary abundance. As demonstrated in Table 2, the sum of the tributary monitoring results and the total counts observed at Willamette Falls in any given year are not equal, indicating some degree of monitoring error most likely associated with expansions of tributary redd counts. The run trends for individual populations have been less dramatic (Figure 2). Individual population sizes vary. The upper South Santiam and the Calapooia populations are smaller than 1,000 fish, and the Calapooia dropped below 100 fish in recent history. The lower South Santiam and Molalla have been larger than 1,000 fish except for a low period during the 1990s, while the North Santiam population has typically stayed above 2,000 fish.

Estimates of intrinsic productivity were based on the alpha (α) parameter of a Ricker model fit to observed spawner and recruit data sets. A 95% confidence interval was calculated around the point estimates. The α parameter represents the productivity of populations at low spawner densities when density dependant mortality is not influencing productivity. Populations are able to increase in size when depressed to low abundance levels if they have α parameters (+/- 95% CI) greater than 1.0. Within the Willamette steelhead ESU, α parameters for the five measured populations ranged from 1.90 to 3.82 with all lower confidence intervals above 1.0 (Table 3).

The actual observed number of recruits per spawner was calculated for the most recent production years. The calculations were made by using the total number of fish present in a brood year as spawners, then assigning recruits to brood years using the age distribution 4% age 3, 56% age 4, 30% age 5, 2% age 6 and 0.02% age 7. For Willamette populations the time period analyzed corresponds with the recruitment from parents that spawned during the years 1993 to 1998. These years range from the period of poor marine survival in the 1990s to a period of increasing marine survival. Populations that have a recruits-per-spawner ratio above 1.0 are replacing themselves; populations with ratios below 1.0 are not producing enough adult offspring to replace themselves. According to this metric, the populations in the Upper Willamette ESU have been relatively productive during the last five brood years (Figure 3). Even in the low survival years of 1993-1995 some populations in the ESU remained above replacement. The Molalla, Calapooia and South Santiam populations have been highly resilient in some years. The apparently less productive, but steady, North Santiam population has also been the largest in recent years. This population may have remained nearer carrying capacity over this period, and thus would not demonstrate a low-density productivity response.

Table 2.   Estimated spawner abundance of wild winter steelhead in selected populations in the Upper Willamette River ESU.

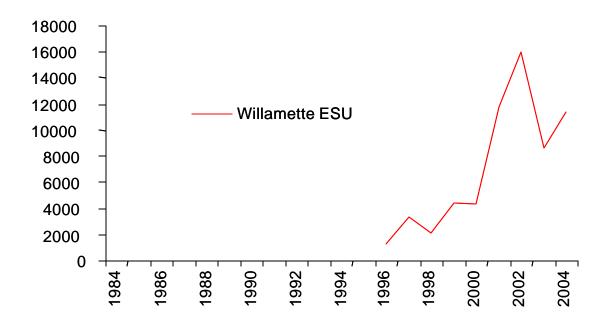| Year	Willamette ESU at Willamette Falls	Molalla	North Santiam	Lower S. Santiam	Upper S. Santiam	Calapooia
1984		2,244	4,010	1,997	504	420
1985		3,129	6,966	3,075	355	555
1986		2,226	3,944	1,964	326	407
1987		2,324	4,523	2,180	214	481
1988		2,757	2,444	2,106	656	439
1989		2,206	4,725	1,411	222	183
1990		2,155	3,707	1,846	272	360
1991		1,398	3,443	2,180	139	309
1992		1,898	2,484	1,906	361	119
1993		577	2,754	1,032	256	39
1994		2,321	2,619	1,811	234	161
1995		898	1,755	1,204	297	109
1996	1,324	398	1,955	972	131	18
1997	3,431	590	2,106	642	336	253
1998	2,179	1,411	2,835	684	359	358
1999	4,414	1,090	2,163	1,076	328	59
2000	4,315	1,898	3,021	1,499	326	225
2001	11,792	1,654	2,375	2,485	783	446
2002	16,039	2,140	3,227	1,274	1,003	351
2003	8,681	2,321	4,010	1,179	850	477
2004	11,433					

Figure 1. Run trend for the entire Willamette ESU, as measured at Willamette Falls.
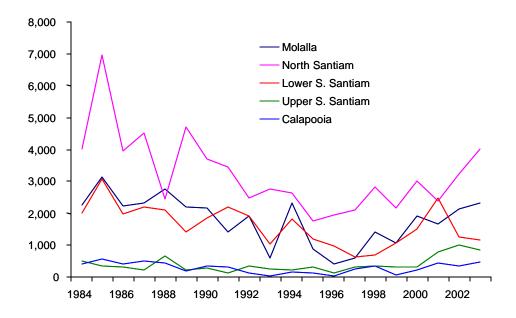

Figure 2. Run trends for individual winter steelhead populations within the Willamette ESU.

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Table 3. Estimates of intrinsic productivity (recruits per spawner at low spawner density) for several wild winter steelhead populations in the Upper Willamette ESU.

Population	Sample Brood Years	Ricker Alpha Value	95% CI for Alpha Vale
Molalla	1980-1997	2.64	1.45 – 4.76
North Santiam	1980-1997	1.90	1.22 – 2.94
Lower South Santiam	1980-1997	2.46	1.32 – 4.62
Upper South Santiam	1980-1997	1.95	1.38 – 2.80
Calapooia	1980-1997	3.82	1.79 – 8.25
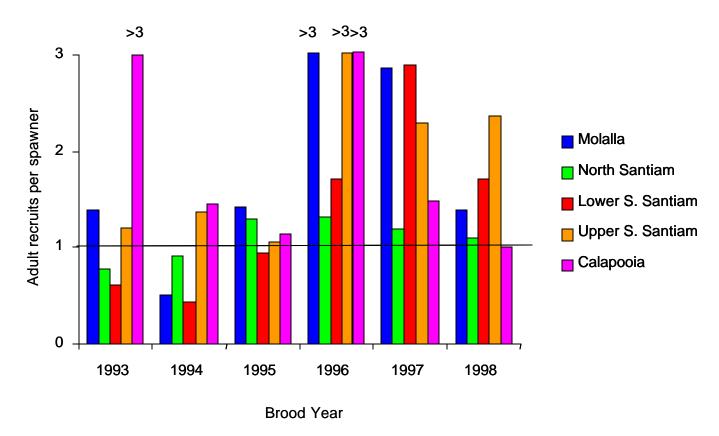
Figure 3.   Observed recruits per spawner for five populations of upper Willamette ESU winter steelhead, 1993 to 1998 brood years.

Lower Columbia ESU abundance trends and productivity (Oregon Basins): The partial abundance of wild winter steelhead in Oregon's portion of the Lower Columbia ESU is monitored at dams in three basins, the Clackamas, Sandy and Hood. Recent abundance trends at these monitoring locations are shown in Table 4 and Figure 4. The Hood and Clackamas populations passed through a low abundance period of fewer than 500 fish in the mid-1990s, and then increased starting in 2000. Data for wild fish are not available for the Sandy population during this low abundance period. The Hood and Sandy populations appear to have peaked in 2002 and since declined, while the Clackamas population continued to increase through 2004. These three monitoring stations intercept only part of the Lower Columbia ESU abundance in Oregon. An approximate expansion to a total ESU abundance, in Oregon, is provided in Table 5. The recent 5-year (2000-2004) average abundance in Oregon's portion of the Lower Columbia ESU was approximately 4,200 wild winter steelhead.

A Ricker model was fit to the Clackamas spawner and recruit data. The estimate of intrinsic productivity (Ricker alpha (α) parameter with a 95% confidence interval) for the Clackamas was 1.57 (CI 0.7 – 3.53) (Table 6). The fact that the lower confidence interval was below 1.0 suggests that this population may not have been self-sustaining at recent levels of productivity.

The actual observed number of recruits per spawner was calculated for the most recent production years (1993 – 1999) for the Clackamas, Sandy and Hood (Figure 5). According to this metric, the Sandy population was the weakest in that it was below replacement in five out of the seven years evaluated. The Hood and Clackamas populations were also below replacement early in the evaluation period, but improved in recent years. The results for the Hood are overestimated since some hatchery fish were in the basin but were not included among the spawners in the calculations.

Table 4.   Abundance trends of major Oregon populations in the Lower Columbia ESU.

Year	Clackamas	Sandy	Hood
1984	1,238		
1985	1,225		
1986	1,432		
1987	1,318		
1988	1,773		
1989	1,249		
1990	1,487		
1991	829		
1992	2,106		697
1993	1,174		397
1994	1,218		378
1995	1,131		194
1996	203		270
1997	273		275
1998	265		209
1999	133		290
2000	442	742	908
2001	893	902	1,000
2002	1,328	1,031	1,034
2003	1,230	671	717
2004	3,110	870	472
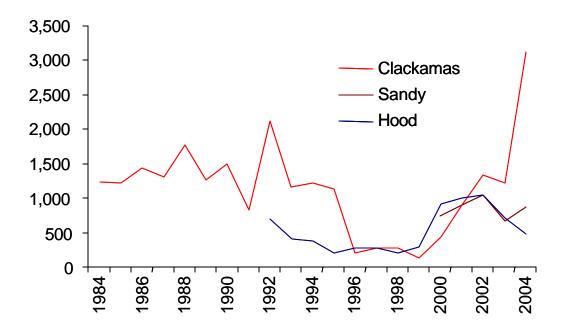
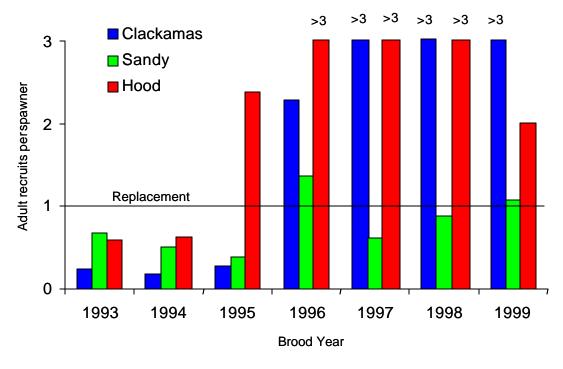Figure 4. Run trends for three Oregon wild winter steelhead populations in the Lower Columbia ESU.

Figure 5. Estimated adult recruits per spawner in three Oregon winter steelhead populations in the Lower Columbia ESU for the 1993 – 1999 brood years.

Table 5. Expansion of listed ESUs and populations of winter steelhead in Oregon.

Basin	Counting Station (Dam counts)	Average size 5 years (00-04)	Range in Size		Approx. % of basin population represented	Estimated total average abundance (2000-2004) (rounded)
			High	Low		
Willamette (Will ESU)	Willamette Falls ladder	10,450	16,039 (2002)	4,315 (2000)	100% (of ESU)	10,450
Scappoose (LwCol ESU)	Bonnie Falls Ladder (NFk)	16	24 (2003)	8 (2002)	~50% based on recent redd counts in mainstem and SFk	~50
Other Willamette tributaries below Willamette Falls (LwCol ESU)	Not monitored	Probably less than 50 fish			NA	~50
Clackamas (LwCol ESU)	North Fork Dam ladder	1,400	3,110 (2004)	442 (2000)	~80% according to ODFW Basin Plan. Probably closer to 65% - 70%	2,000
Sandy (LwCol ESU)	Marmot Dam Ladder	840	1,031 (2002)	671 (2003)	~80% according to ODFW Basin Plan. Probably closer to 70% - 75%	1,200
Hood (LwCol ESU)	Powerdale Dam ladder	825	1,034 (2002)	472 (2004)	100%	825
Gorge Tributaries (both above and below Bonneville Dam) (LwCol ESU)	Exploratory surveys started in 2004.	Estimated total of 100 fish			NA	~100
Fifteenmile And adjacent small basins (Mid-Col ESU)	Not regularly monitored	Estimated 400 to 800 fish			NA	~500
Oregon Total (Three listed ESUs) (rounded)						15,000

Table 6. Estimates of intrinsic productivity (recruits per spawner at low spawner density) for several wild winter steelhead populations in the Lower Columbia ESU.

Population	Sample Brood Years	Ricker Alpha Value	95% CI for Alpha Vale
NFk Toutle		2.15	1.87-2.48
SFk Toutle		1.19	0.65-2.25
Green River		2.88	1.99-4.17
Kalama		2.39	1.67-3.42
Clackamas	1980-1997	1.57	0.70-3.53

Lower Columbia ESU abundance trends and productivity (Washington Basins): Washington populations in the Lower Columbia ESU have generally increased in recent years, compared to the poor returns in the 1990's (Tables 7 and 8, Figure 6). During the poor abundance years of 1996-2000, returns to individual basins ranged between 38 and 562 wild winter steelhead as compared to recent years (2001-2004) when returns to individual streams have ranged between 41 and 2,150 wild winter steelhead (Table 7). Long-term databases exist for Coweeman, S.F. Toutle, Kalama, Green, and E.F. Lewis rivers and for these streams counts observed during 2001-2004 have generally been similar to those observed during the late 1980's. Most individual populations in the Washington portion of the Lower Columbia ESU have been under 1,000 fish recently, except the South Fork Toutle and Kalama populations whose abundance typically ranges between 1,000 and 3,000 fish annually. The rest of the Washington populations in the ESU are smaller with several streams having escapements of less than 100 fish. It should be noted that the Green River is only an index of the total population in that system and that most of the spawning area is not surveyed due to budget constraints. The population in the Green may be similar in size to the S.F. Toutle River (Rawding 2004).

For several populations in the lower Columbia ESU, abundance databases extend from 1984 to 2004, which covers alternating time periods of high and low survival rates. The time frame of 1984-1988 represents a period when smolt to adult survival rates were extremely high, while the time frame of 1996-2000 represents a period of extremely poor smolt to adult survival rates. The time period of 2001-2004 represents the recent period of improved smolt to adult survival rates. Average returns during these time periods can be used to show how the current abundances compare to historical abundance levels and how effectively abundance levels rebounded from years with poor smolt to adult survival rates. Adult abundance levels during 2001-2004 have generally been similar to abundance levels observed during the high survival years of 1984-1988 and have dramatically increased from the poor survival years of 1996-2000 (Table 7).

Similar trends of improved returns in recent years have also been observed for the Willamette ESU and in other populations in the lower Columbia River ESU, as compared to the Washington tributaries in the Lower Columbia ESU. The recent 4-year average

(2001-2004) abundance for the lower Willamette ESU was 12,000 wild winter steelhead as compared to the 1996-2000 average of 3,000, which represents a 4-fold increase in abundance (Table 2). For the Clackamas population abundance increased from 263 during 1996-2000 to an average of 1,640 during 2001- 2004 (624 % of 1996-2000 average) and for the Hood population abundance increased from 390 during 1996-2000 to an average of 805 during 2001- 2004 (206 % of 1996-2000 average) (Table 4).

Table 7. Abundance of wild winter steelhead in Washington's Lower Columbia River ESU tributaries during the time frames of 1984-1988, 1996-2000 and 2001-2004.

Stream	1984-1988		1996-2000		2001-2004		2001-2004 Ave as % of	
	Range	Ave	Range	Ave	Range	Ave	84-88 Ave	96-00 Ave
SF Toutle	836-2,222	1,622	150-562	393	348-1,510	982	61 %	250 %
NF Toutle	NA	NA	133-251	191	185-410	923	NA	482%
Coweeman	NA	NA	44-530	273	298-722	466	NA	171%
Kalama	532-982	911	413-817	578	922-2,150	1,520	167 %	263 %
Green	310-775	496	72-132	111	192-438	267	54 %	241 %
E. F. Lewis	192-282	244	133-442	363	328-1,298	641	262 %	177 %
Cedar Ck	NA	NA	38-78	62	41-237	103	NA	166%

Escapement goals have been established for six of the eight Washington tributaries of the Lower Columbia ESU. Since 2001, the Kalama and E.F. Lewis rivers have consistently achieved escapement goals and the S.F. Toutle and Washougal rivers have achieved their escapement goals in two (2003 and 2004) of those years (Table 8). During the poor return years of 1994-1998 when the stock was listed, the escapements goals were not achieved in these areas, while populations were generally at or above escapement goals during the good survival years of 1984-1988.

Ricker models were fit to the North and South Fork Toutle, Green, and Kalama rivers spawner and recruit data. The estimate of intrinsic productivity (Ricker alpha (α) parameter with a 95% confidence interval) for these four rivers ranged from 1.19 to 2.88 (Table 6). The lower confidence interval for the South Fork Toutle was below 1.0, which suggests that this population may not have been self-sustaining at recent levels of productivity; however, returns since 2001 have been on an increasing trend and the escapement goal was achieved in the last two years, for the first time since 1993. The confidence intervals for the other three populations were above 1.0, which suggests that these populations are replacing themselves.

The actual observed number of recruits per spawner was calculated for the most recent production years (1993 – 1999 broods) for the Coweeman, North and South Forks of the Toutle, Kalama, and Green rivers (Figure 7). Since brood year 1996, most populations have been above replacement, with the Coweeman, Kalama and Green populations particularly resilient. Only the 1996 brood for the South Fork Toutle and the 1998 brood for the Coweeman did not exceed replacement. For the 1998 and 1999 broods most stocks are exhibiting spawner per recruit ratios of 2.0-3.0. In comparison to the

Washington tributaries, the 1996 and 1997 broods for the Oregon tributaries of the Lower Columbia ESU exhibited a very strong response to improved conditions with most populations (six of ten) exceeding a 2.0 recruit per spawner ratio.

Mid-Columbia ESU: The mid-Columbia ESU is composed primarily of summer steelhead with a few small winter steelhead populations in the most western portion of the geographic range. All winter populations in the mid-Columbia ESU are small and unmonitored. Oregon estimates that there are about 500 winter steelhead distributed across several small basins centered near Fifteenmile Creek. Washington populations are centered near the Klickitat. More accurate abundance estimates and productivity information are not available for winter steelhead populations in this ESU.

Relationship between abundance trends and marine survival: The recent increase in winter steelhead abundance is most likely associated with increased marine survivals for these populations. Figure 8 presents smolt to adult escapement survival trends for two Oregon populations in the Lower Columbia ESU (the Clackamas and Hood). A sharp increase in smolt-to-adult survival is very evident for the Clackamas population, but a similar trend is not as obvious for the Hood population. Ocean distributions of steelhead are not as well understood as for other salmonids, but it appears that steelhead distributions may be variable in the north Pacific, perhaps by population, with fish found along both the coast of British Columbia and SE Alaska and further offshore in the mid-North Pacific (Burgner et al. 1992).

Table 8. Abundance of wild winter steelhead in Washington index areas in the Lower Columbia River ESU.

Year	Coweeman	SF Toutle	NF Toutle	Kalama	Cedar Creek	Washougal	Green Index	EF Lewis Index
1984		836		943				
1985		**1,807**		632			775	
1986		**1,595**		919				**282**
1987	889	**1,650**		982			402	**192**
1988	**1,088**	**2,222**		**1,079**			310	**258**
5-Yr Ave	*989*	*1,622*	*--*	*911*	*--*	*--*	*496*	*244*
1989	392	**1,371**	18	506			128	140
1990	522	752	36	356			86	102
1991		904	108	959		114	108	72
1992		**1,290**	322	**1,974**		142	44	88
1993	438	**1,242**	165	843		118	84	90
5-Yr Ave	*451*	*1,112*	*130*	*928*	*--*	*125*	*90*	*98*
1994	362	632	90	725		158	128	78
1995	68	396	175	**1,030**		206	174	53
1996	44	150	251	725	70		108	
1997	108	388	183	456	78	92	132	192
1998	486	374	149	413	38	195	118	**420**
5-Yr Ave	*214*	*388*	*170*	*670*	*62*	*163*	*132*	*186*
1999	198	562	133	478	52	294	72	**476**
2000	530	490	238	817	73		124	
2001	384	348	185	922	41	216	192	**328**
2002	298	858	328	**1,355**	88	286	180	**316**
2003	460	**1,510**	410	**1,699**	237	**764**	438	**624**
5-Yr Ave	*374*	*754*	*259*	*1,054*	*98*	*390*	*201*	*436*
2004	722	**1,212**	249	**2,150**	44	**1,114**	256	**1,298**
Esc. Goal	1,064	1,058	--	1,000	328	520	--	204

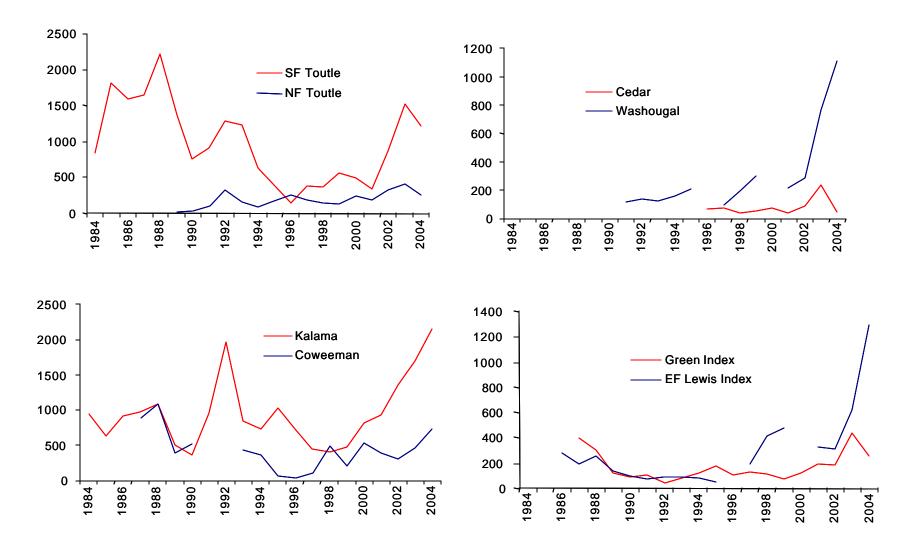Note: Bold numbers denote escapement goals achieved.

Figure 6. Run trends for Washington wild winter steelhead populations in the Lower Columbia ESU.
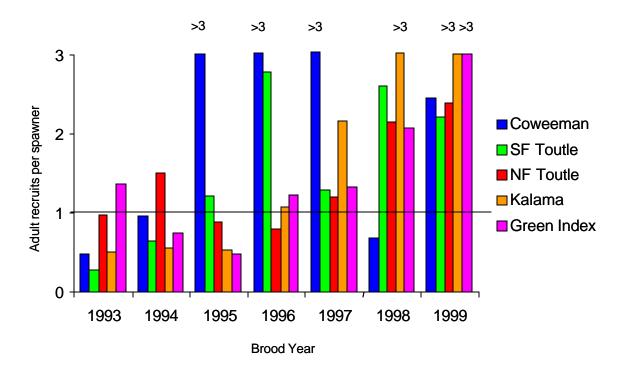
Figure 7. Estimated adult recruits per spawner in Washington winter steelhead populations in the Lower Columbia ESU for the 1993 – 1999 brood years.
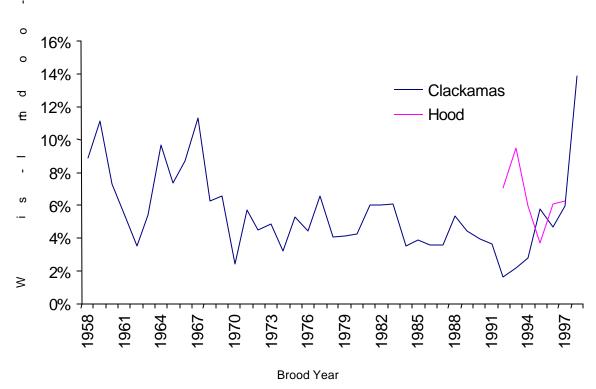
Figure 8. Wild steelhead smolt-to-escapement survival in the Clackamas River (1958-1998 brood years) and in the Hood River (1992-1997 brood years).

Weak populations: It is evident from the above discussion that the Willamette ESU and its component populations are relatively resilient. Although some individual populations in this ESU were very small during the 1990's, productivity analyses demonstrate that these populations responded to the small sizes with a strong productivity response (Table 3). As a result, the ESU as a whole has increased significantly in size since the mid-1990s. The status of the Lower Columbia ESU is generally weaker and individual populations in this ESU are generally smaller than those examined in the Willamette ESU. While most populations in the Lower Columbia ESU have generally increased some populations remain very small, containing only a few hundred fish, although for Washington tributaries with established escapement goals, three of the six rivers have escapement goals of 500 fish or less (Table 8).

For any population, the impact of additional life cycle mortality (whether due to fisheries, dams, or habitat degradation) will put the persistence of the population at high risk if the cumulative result is that the net productivity declines to a rate less than 1.0 recruit per spawner. The improved recruit per spawner ratios and the generally improved abundance in recent years indicate that most populations are responding favorably to improved marine survival conditions; therefore, at least in the short term, a modest increase in mortality due to the proposed fishery actions should be countered by the much stronger effect of favorable ocean conditions. Additionally, the highly varied age distribution of steelhead should buffer the weaker populations and weak brood years from the proposed increase in fishery related mortalities. However, the long-term strategy for wild winter steelhead needs to be one that is responsive to changes in marine survival conditions and

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that recognizes the variation in productivity and abundance levels among the different populations.

2. Run timing and variable vulnerability of ESUs and populations to fishery impacts.

Under the existing biological opinion, the states of Oregon and Washington have managed non-Indian fisheries to not exceed a 2% impact on the aggregate wild winter steelhead run. The aggregate included wild winter steelhead from four Columbia Basin ESUs: the SW Washington ESU (which is not listed), the Willamette ESU, the Lower Columbia ESU, and the Mid-Columbia ESU. As part of the preliminary risk analysis of a possible increase in the impact rate, the states recognized that run timing differences might exist between the ESUs, in particular between the Willamette and Lower Columbia ESU's, and among populations within the Lower Columbia ESU. If run timing differences do exist between or within ESUs, then the actual impacts to individual stocks may differ from an impact rate that is measured against the aggregate wild winter steelhead population. The commercial fishery occurs in the mainstem Columbia River primarily during the month of March. Populations would be more vulnerable to the commercial fishery if they pass through the mainstem Columbia when the fishery is occurring while other populations may be later-timed, passing the through the mainstem after the fishery is over, or earlier-timed, passing the through the mainstem before the fishery starts.

Data collected from tributaries with dams or weirs indicates that run timing varies among winter steelhead in the lower Columbia when run timing is measured in tributaries. Oregon tributaries downstream of the Willamette appear to have very early run times, such as Scappoose Creek, which peaks in February (Table 8). Scappoose Creek is the western-most Oregon population in the Lower Columbia ESU. Similar run timing occurs at the Big Creek weir further down river, which is part of the SW Washington ESU. The Clackamas has a very late run time, with the peak in early May (Table 8, Figures 9 and 10). The Willamette is a relatively early run, with a peak run time at Willamette Falls in mid-March (Table 8, Figures 9 and 10). All other populations for which data are available have peak run times at their tributary dam or weir in early to mid-April (Table 8, Figures 9 and 10).

The relationship between run timing in tributaries and run timing through the mainstem Columbia is influenced by many variables. These variables include the time of entry into the mouth of the Columbia, travel time through the Columbia, any holding behavior that occurs during passage through the Columbia, and the distance to the natal tributary. The tributary counting stations are located at various distances from the tributary river mouths, and the tributary river mouths are located at different distances from where the fishery occurs (Table 8).

Table 8. Distance to Traps/Weirs in Selected Tributaries of the Lower Columbia River and average passage dates at these monitoring sites.

Tributary	Approximate distance from Zone 2 (~RM 40) (in miles)	Earliest (1) to latest (7)	Average 10% Passage Date	Average 50% Passage Date	Average 90% Passage Date	Percent of population passing the tributary site during Feb 28-Mar 27
Kalama	40	5	28-Feb	8-Apr	14-May	25%
NF Toutle	55	3	3-Mar	3-Apr	30-Apr	37%
Scappoose	60	1	9-Jan	4-Feb	22-Mar	
Willamette	125	2	22-Jan	19-Mar	22-Apr	27%
Sandy	150	4	9-Feb	5-Apr	13-May	23%
Clackamas	160	7	23-Mar	5-May	25-May	5%
Hood	175	6	14-Mar	16-Apr	14-May	13%

Time of entry into the Columbia: Winter steelhead are detected in their natal tributaries as early as November; however, it appears that few winter steelhead are caught in October coho gill net fisheries in the mainstem Columbia. Although monitoring to specifically detect winter steelhead by-catch in this fishery does not occur at this time, data from past fisheries is available to estimate relative steelhead handle during this time frame. Winter steelhead continue to pass into their tributaries into June, or even into July in the case of the Clackamas and Hood rivers. The end date for entry into the Columbia is unknown.

Travel time and holding behavior through the Columbia: Information about winter steelhead travel time and behavior through the mainstem Columbia River is limited. Two studies of winter steelhead movement through the mainstem are available for consideration in this report. One study is historic, based on tagging done in the 1950s (Korn 1961) and the other study was confined to Bonneville Pool.

Wild winter steelhead were tagged by WDFW (unpublished data) at Bonneville Dam during 2001-2002 and their travel time to the Hood River was determined by recaptures at Powerdale Dam. The distance between the location of tagging and the recapture site was approximately 30 miles. The results demonstrated that individual fish crossing Bonneville Dam had high variation in their travel time through Bonneville Pool to Hood River, with the later fish over Bonneville Dam traveling faster. Travel times ranged from about 20 days up to 120 days. At a distance of 30 miles, travel rates ranged from 1.5 miles per day to 0.25 miles per day in the Bonneville Pool. There was a positive relationship between the dates the fish were tagged versus travel time to recovery. The later the fish was tagged the faster the fish traveled from Bonneville Dam to Powerdale Dam ($R^2 = 0.66$) (Figure 11).

The slow travel times observed in this study seem unlikely to occur as fish move upstream from the mouth to Bonneville Dam. If fish moved at similar slow speeds through the lower river they would have had to enter the mouth of the Columbia the

previous summer. Based on a lack of observations of winter steelhead being captured in October coho fisheries, it is unlikely that winter steelhead are entering the Columbia prior to late October.

It is also important to note the tagging dates in the Bonneville-to-Powerdale study. Most tagging occurred from early December to mid-March, while the peak of the run over Bonneville Dam appears to be in early April (Figure12). A comparison of the peaks of the run over Bonneville and over Powerdale indicate faster run times at the peak of the run, closer to 2 or 3 miles per day (Figure 11). This result would be consistent with the results of the regression, which demonstrated that fish moved faster as they neared the peak of the run.
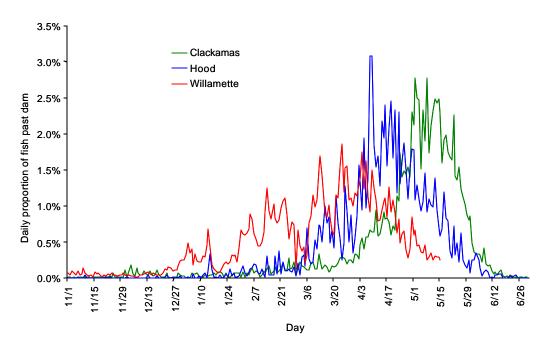
Figure 9. Average run timing of the Willamette ESU (measured at Willamette Falls), of the Hood River winter-run population (measured at Powerdale Dam) and of the Clackamas population (measured at North Fork Dam.
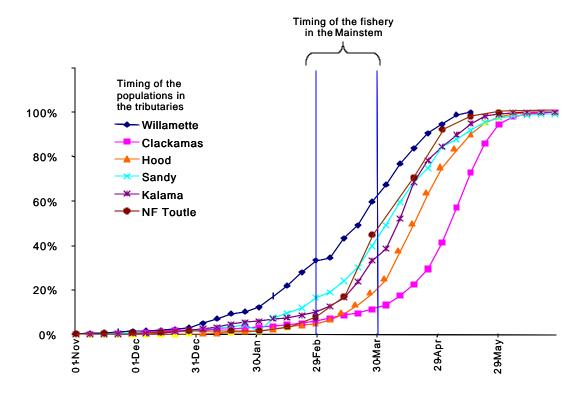
Figure 10. Cumulative passage times into escapement areas in selected tributaries of the Lower Columbia River.
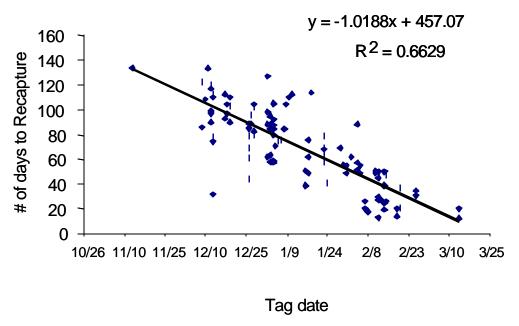
$$y = -1.0188x + 457.07$$

$$R^2 = 0.6629$$

Figure 11. Travel time for wild winter steelhead tagged at Bonneville Dam and recaptured at Powerdale Dam, Hood River. Approximate distance between tagging and recapture locations is 30 miles.
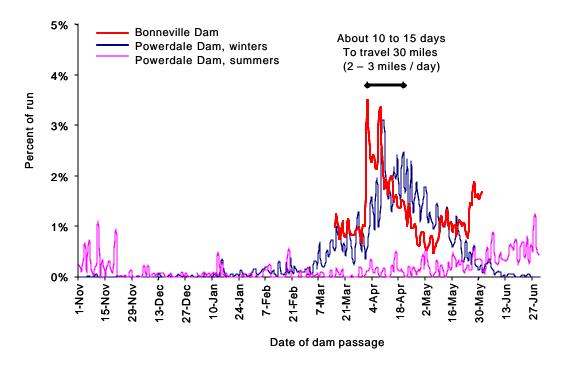
Figure 12. Times of passage at Bonneville Dam and Powerdale Dam. The Hood River fish make up about 30% - 40% of the fish counted at Bonneville. Plot based on average run time of wild fish for 1993-2003. Counts of winter steelhead prior to March 15 at Bonneville Dam were not available until recently.

Another tagging study occurred in the lower mainstem Columbia River during 1954-1956 Korn (1961). Results of the study indicated that winter steelhead passed through the lower Columbia River (Areas of Zones 1 and 2) from late November through mid-April with the vast majority of the winter steelhead migration occurring during the month of March. According to Korn, "Numbers of tagged steelhead remained or milled in the Columbia River up to 20 days and occasionally a month or more prior to entering the tributaries." However, Korn also noted that "It is not possible to estimate from the tagging data the numbers of steelhead remaining in the lower Columbia River or the length of time involved." Fish were recaptured in tributaries, distributed from Grays River to Klickitat River, from within a few weeks of tagging to months after tagging but detailed information about dates of tributary entry were not possible because most recaptures came from sport fisheries. The effect of this milling behavior in the lower mainstem might mix populations from the various tributaries and mask possible run timing differences. The applicability of these results to current fish behavior is unknown since the hydrology of both the Columbia and Willamette has changed significantly since the 1950s due to dam construction.

Tributary Distance: Distances between the mainstem commercial fishing areas and the tributary monitoring stations varies. The Washington tributaries in the Lower Columbia ESU enter the mainstem in fishing Zones 3 through 6 while the Oregon tributaries enter the mainstem in Zones 4 through 6. A substantial amount of the non-tribal commercial fishing effort occurs in Zone 2, although non-tribal fishing regularly occurs in Zones 1, 2, and 3 while tribal fishing occurs in Zone 6. The counting stations where tributary run times are measured are located at various distances above the mouths of the rivers. Table 8 includes an estimate of the distance between the approximate center of the Zone 2 fishing area and the tributary counting stations.   The table also lists the average 10%, 50%, and 90% passage dates in the tributaries and the estimated percent of the fish passing the tributary monitoring sites during the fishing period. The distances to the tributary counting stations are not necessarily related to the average passage dates in that the fish with the furthest distances to travel are not necessarily the latest to arrive at their monitoring stations.

Efforts to estimate passage time in the Zone 2 fishery: The 2004 work group made an attempt to explore the implications of differences in run timing at the weirs/dams in the tributaries to the timing of the fish in the fishing area. The group wanted to address the question of what percent of a given ESU would be present during the fishery occurring in Zone 2 in month of March; however, it became evident during the modeling that the answer to this question was very sensitive to our assumptions about how fish traveled through the mainstem.

A model was generated using the following assumptions:

1) The effort and catch occurred in Zone 2. Actual non-tribal fishing has recently occurred in Zones 1-3; however, the highest steelhead by-catch has been in Zone 2, which was therefore used as the fishing area in the model

2) The time of passage at the tributary counting stations establishes the shape of the passage curves. In other words, it was assumed that fish within the ESUs entered the Columbia from the ocean according to the same shaped curve and then moved in the same relative time through the lower Columbia as they did over the dam or weir where they were counted.

3) An average passage time and an average distance between Zone 2 and the tributary counting station was used for the Lower Columbia ESU. Actual passage times and tributary distances for populations within this ESU vary (see Table 8).

4) The model assumes that the fish in the ESUs move at some average travel time and that this rate is the same for all individual fish. A range of average travel times from 1 to 12 miles per day were used in this analysis. Although the use of an average travel time implies that actual travel times may vary around that average, the model essentially treats travel time as a point-estimate constant value.

Timing curves were plotted for the Willamette ESU and the Lower Columbia ESU. Based on these curves, estimates of the percent of the ESUs that were present in the Zone 2 fishing area under different assumptions of average travel time were generated (Table 9). Results for four average travel times of 1 mile/day, 2 miles/day, 5 miles/day and 10 miles/day are also shown in Figure 13.

The models indicate that if the average travel time were 1-3 miles per day, the populations in the Lower Columbia ESU were 2 to 4 times more vulnerable to the Zone 2 fishery than the fish in the Willamette ESU. The differences in the proportion of the two ESUs that was available during the fishery ranged from 10% to 19%. The two ESUs were equally vulnerable to the Zone 2 fishery if the travel time was 4-8 miles per day and at faster travel times (8-12 miles per day) the vulnerability of the Willamette ESU was slightly higher. At these faster travel times (4-12 miles per day) the differences in the proportion of the fish present when the fishery is occurring between the two ESUs (Willamette and Lower Columbia) ranged from 1%-7%. Another result was that at slow average travel times the vulnerability of both ESUs was lower (less than 15% of the populations exposed) compared to the vulnerability of both ESUs at faster average travel times (more than 30% of the populations exposed).

If the assumptions in this model were accurate, and travel time averaged at least 4 miles per day, the percent of the ESUs that were vulnerable to the fishery would not differ very much. The only available studies have demonstrated very slow travel times, which implies substantial holding behavior. If these same travel times also occurred below Bonneville dam, an unrealistic date of entry into the Columbia River would be required (as early as mid-summer for the slowest fish observed). The Bonneville Pool results might be better explained by a behavior where fish move rapidly through some parts of the mainstem, but very slowly through other parts of the mainstem (slowly through Bonneville Pool, in the case of the tagging study). Results of this study do suggest that the travel times to the tributaries vary as the fish get closer to spawning; however, whether this data is applicable to steelhead destined for lower river tributaries is

unknown. These results suggest that the modeled assumptions about travel times do not encompass actual fish behavior and that episodes of slower and faster travel time must occur.

The models took into consideration the location of the mouths of the natal tributaries relative to the fisheries only in the sense that the timing distribution at the tributary counting station was extrapolated back to the Zone 2 fishing area based on miles to the tributary and assumed travel time (miles/day). An average distance from the fishing area to tributary counting locations was used for the entire Lower Columbia ESU, although actual distances for different tributaries varies (Table 8).

The location of the tributary relative to the fishing zones may have other important ramifications. One hypothesis might be that if populations move quickly through the mainstem then hold near the mouths of their natal tributaries then those populations with natal tributaries entering in the Zone 2 fishery would be relatively more exposed to the fishery than those populations in other tributaries that enter other fishing zones. The tributaries occupied by unlisted populations in the SW Washington ESU enter the mainstem in Zones 1-3. Some Washington tributaries in the Lower Columbia ESU enter the mainstem Columbia River in the Zone 3 fishery while others enter upstream in Zones 4 or 5 where fishing does not occur (including the Willamette ESU and all Oregon tributaries). Another hypothesis from the Korn study would be that the fish may be milling around in the lower Columbia River just after entering the river and prior to moving on to their natal stream.

Further studies concerning wild winter steelhead migration patterns through the lower mainstem Columbia are needed. Until additional data are obtained, any further analysis of travel time would have to rely on models that contain important assumptions or on the results of the recent WDFW tagging study. Useful new studies may include the tagging of winter steelhead that are intercepted in the fishery and recaptured in tributaries and other terminal areas. This study would provide direct information about which ESUs/populations are being taken as fishery by-catch, and would also provide information about travel time and post-release survival. Another useful study may be a Genetic Stock Identification analysis of steelhead taken as by-catch. In this study, a genetic mixture analysis would be used to assign proportions of the catch to the different ESUs. The genetic baseline that was used to establish the boundaries of the four Columbia Basin ESUs that contain winter steelhead may be useful in such an analysis since the ESUs are each very distinctive in the baseline. However, the existing baseline is an allozyme data set. Non-lethal fin clip samples would restrict the analysis to those allozymes that are detected in dermal tissue. Such a restricted analysis has been used with success in other studies. Another option would be to create a new baseline data set that is more conducive to non-lethal sampling. The creation of a new micro-satellite DNA baseline would require substantial new sampling and analysis of wild winter steelhead populations from all four Columbia Basin ESUs. A genetic mixture analysis based on a micro-satellite baseline is not more accurate than one based on an allozyme analysis; rather, the advantage is in the ability to rely on non-lethal sampling.

Table 9. Modeled percents of the Lower Columbia ESU and Willamette ESU that are present in the area of the Zone 2 fishery under different assumptions of travel time.

Assumed travel time (miles/day)	Percent of Population in Zone 2 during March		
	Lower Columbia ESU	Willamette ESU	Difference
1	13	3	10
1.5	31	12	19
2	36	19	17
3	38	27	11
4	37	30	7
5	37	30	7
6	34	32	2
8	32	33	1
10	31	33	2
12	30	34	4
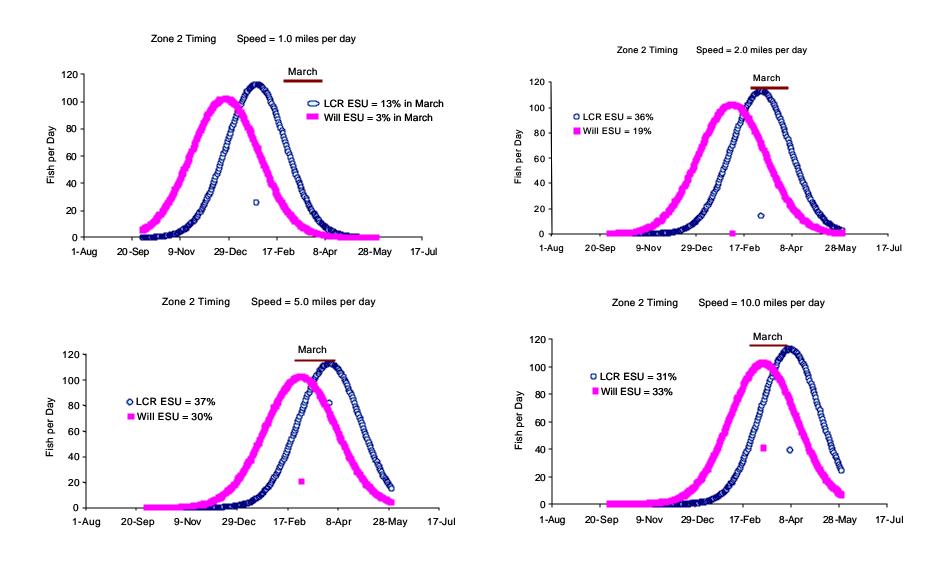
Figure 13.   A model of relative run timing in the Zone 2 fishery (March). The timing for the Willamette ESU and for an average of the Lower Columbia ESU are shown under four different travel times.

3) Pre-season Run Size Forecasts and In-season Run Updates

The TAC committee has provided preseason run forecasts for salmon and steelhead stocks in the Columbia River, with assistance from the state and tribal staffs. Forecasts for wild winter steelhead were made for 2003 and 2004 (Table 10). These forecasts are for an aggregate return to all four Columbia Basin ESUs that have winter steelhead (SW Washington, Lower Columbia, Willamette, and Mid-Columbia).

Table 10. Past TAC forecasts of wild winter steelhead, compared to actual returns.

Wild Winter Steelhead Returns to the Columbia River.		
Year	Predicted Return	Estimated Actual Return
2002	--------	37,660
2003	15,500	26,700
2004	32,200	33,900

The methodology that was used in 2003 was a regression of wild 1-salt summer steelhead in year i-1 versus the wild winter steelhead index in year i. The wild winter steelhead index included Washington tributaries that have been routinely surveyed and Willamette Falls counts. The estimate was then expanded (0.528) to include other tributaries that were not part of the index count (Table 11). The rationale for this predictor was that the 1-salt wild summer steelhead would have entered the ocean in the same year as the wild winters and therefore would have experienced the same in-river and ocean conditions.

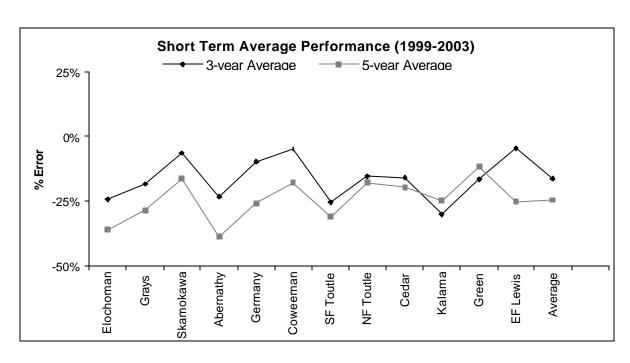Table 11. Regression used to forecast the 2003 winter steelhead run.

2003 Wild Winter Steelhead Forecast
Total wild 1-salt summer vs. wild winter index - 9 yrs

Regression Output:

Constant	2963.8674
Std Err of Y Est.	1445.5674
R Squared	0.9216807
No. of Observations	9
Degrees of Freedom	7
X Coefficient(s)	0.16060667
Std Err of Coef.	0.017695326

Regression output = 8,169
Estimate =   8,169/0.528 = 15,500

The methodology that was used in the 2004 forecast was a two-year average of the 2002 and 2003 returns. The rationale was that the trends in the returns were positive and that a recent year average should result in a reasonable and conservative estimate.

As part of the 2004 work group meetings, both state agencies reviewed methods for predicting tributary abundance based on historic data. The WDFW completed an analysis that included three year and five years averages to forecast the current year and hind cast previous years to assess the accuracy of these methods. Data from twelve Washington tributaries were analyzed beginning in 1984 for some tributaries. The ODFW reviewed historic data for the Clackamas River to test the predictions against actual returns. The Clackamas data set includes wild adult dam counts and wild juvenile out-migrant counts back to 1958. Run size predictions using several methods were compared to actual returns for each year from 1960 to 2003 and the amount of error in the predictions compared to the actual runs were determined. More limited methods were tested on the Willamette, Sandy and Hood populations.

WDFW analysis concluded the three-year average predictor was more accurate in the short term (five-year average) and the five-year average predictor was more accurate over the long term (ten-year average). Over the short-term range, the three-year average method had an error rate of 5%-30% and the five-year average method had an error rate of 12%-39% (Figure 14). Over the long-term range, the three-year average method had an error rate of 16%-63% and the five-year average method had an error rate of 25%-70%.

Over the recent 5-year period (1999-2003) the three-year predictor method represented 84% of the actual returns, ranging in accuracy from 70% on the Kalama to 95% on the Coweeman River. The five-year predictor method represented 75% of actual returns, ranging in accuracy from 61% on Abernathy Creek to 88% on Green River. Averaging over a 10-year period (1994-2003) the three-year predictor method tends to over predict with a 24% error, ranging in accuracy from 84% on Cedar Creek and 163% on the Elochoman River. The five-year predictor method was accurate within 17% on average, ranging from 75% on the Coweeman River and 170% of the actual return on Abernathy Creek.

Short Term Average Performance (1999-2003)
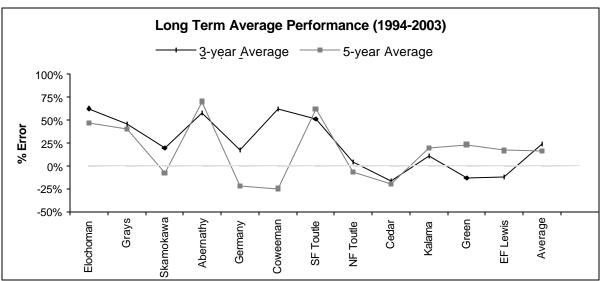

Long Term Average Performance (1994-2003)

Figure 14. Performance of forecasting methods on Washington tributaries (5-year and 10-year averages).

The methods investigated by the ODFW included:

1. Method 1 used smolt counts and previous year's smolt-to-adult survival. This method used three-year and five-year averages of smolt-to-adult survival rates, but other options could also be used. Predictions were generated for 38 years for the three-year average and 36 years for the five-year average. Predictions were compared to actual abundances using the Clackamas River smolt and adult data set. Over the entire series the ranges of error for the three-year average was from a 73% over estimate to a 194% underestimate (Figure 15). The predictor was within 25% of the actual abundance in 53% of the years. Over the entire series the ranges of error for the five-year average was from a 72% over estimate to a 267% underestimate. The predictor was within 25% of the actual abundance in 44% of the years. The use of this method is restricted to those basins where accurate smolt and adult abundances are available.

2. Method 2 used a regression of adults on smolts. In this review, various age structures were incorporated into the analysis. A model with a "simple" age structure of 2 and 3 salt adults generated predictions for 43 years and compared them to actual abundances using the Clackamas River smolt and adult data set. Over the entire series the range of error was from a 77% over-estimate to a 188% under-estimate (Figure 16). The predictor was within 25% of the actual abundance in 53% of the years. The use of this method is restricted to those basins where accurate smolt and adult abundances are available.

3. Method 3 used a running average of previous years. This method used three-year and five-year averages but other options could also be used. We generated predictions for 43 years for the three-year average and 41 years for the five-year average and compared them to actual abundances using the Clackamas River adult data set. Over the entire series the ranges of error for the three-year average was from a 77% over-estimate to a 250% under-estimate (Figure 17). The predictor was within 25% of the actual abundance in 33% of the years. The ranges of error for the five-year average were from an 80% over-estimate to a 262% under-estimate. The predictor was within 25% of the actual abundance in 32% of the years. This method can be used in any basin where accurate adult abundances are available. Examples of predictors for the Willamette and Sandy basin populations were also generated and the error rates for these basins were within the range of those observed using data from the Clackamas River.

4. A fourth method is available for use in the Hood River. This method uses age data to predict future year's abundance from younger age class returns (1-salts and 2-salts). Only about 10 years of data are available to test this method. Over these years this method has had errors of about +/- 30%. This method depends on having highly accurate adult age data, which is not available for most other winter steelhead populations.

Among the methods investigated by ODFW, the three-year and five-year averages of previous adult returns had the highest error rates, falling within 25% of the actual run size only about one-third of the time. Methods that incorporated actual smolt or adult age

distribution information had lower error rates, falling within 25% of the actual run size about half of the time. However, the more accurate methods require smolt abundance and age distribution data, which are not available for most winter steelhead populations. Results of ODFW and WDFW analyses indicate that all predictors worked well when population trends were stable and population sizes were about average; however, rapidly increasing runs and larger than average runs were always under-predicted while rapidly decreasing runs and smaller than average runs are always over-predicted. The magnitude of error in under-predictions was greater than the magnitude of error in over-predictions using these methods (in other words, the biggest mistakes occurred when the population was doing better than expected).

The analysis presented here will be provided to the TAC with the recommendation that individual tributary forecasts be considered as a valid forecasting method. The work group may provide a recommendation to the TAC on the appropriate methodology.
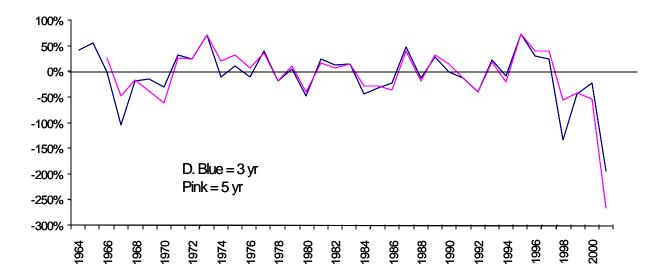

Figure 15. Annual error rate of forecasts made by using actual smolt counts and an average of previous-years smolt-to-adult survivals. Two methods were tested: a three-year average smolt-to-adult survival and a five-year average smolt-to-adult survival. A zero error value means the forecast exactly predicted the actual run. Positive error rates mean the forecast over-estimated the actual run (the actual run was smaller than expected) while negative error rates mean the forecast under-predicted the actual run (the actual run was larger than expected.)
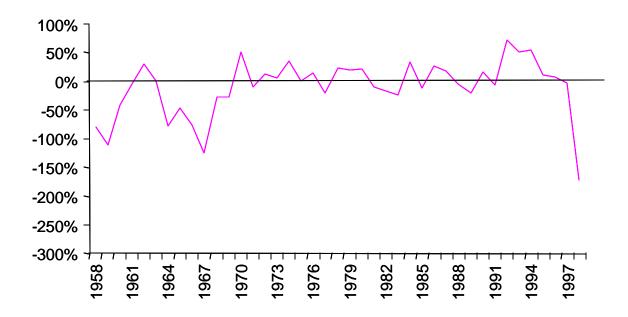
Figure 16. The error rates of forecasts made by a regression of adults on actual smolts ($R^2 = 0.54$). Interpretation of error rate values is the same as in Figure 15.
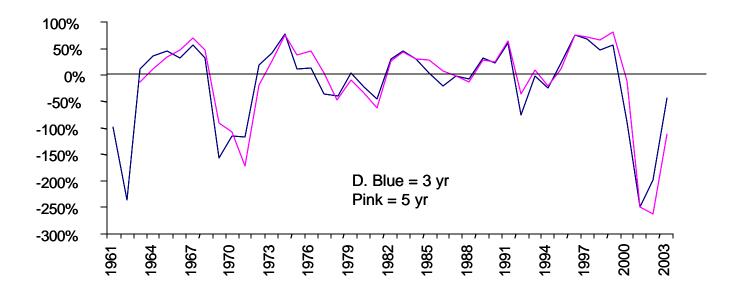

D. Blue = 3 yr
Pink = 5 yr

Figure 17. The error rates of forecasts made by using a three-year and five-year average of previous year's adult returns. Interpretation of error rate values is the same as in Figure 15.

In-season run updates

ODFW has developed an in-season run update model for the Willamette, Clackamas, Sandy and Hood rivers, plus Bonneville Dam using daily counts of steelhead at dams and historic average timing data at the same counting facilities. Run size updates can be made in-season at regular intervals: daily at Bonneville, monthly on the Clackamas, Sandy and Hood, and at least twice a month on the Willamette. The Willamette model provides an in-season update for the entire Willamette ESU; however, the Sandy, Clackamas, Hood and Bonneville dam counts only encompass a portion of the Lower Columbia ESU. These basins can be used as indices, or the results can be expanded to the entire ESU using some estimate of what proportion of the ESU is comprised by these basins. ODFW provided an example of an expansion for the Oregon populations in the ESU in Table 5. It is not clear whether this information can be used in-season to accurately manage the fishery.

4.   Monitoring and Evaluating the Fisheries: Estimating winter steelhead bycatch in the non-Indian commercial fishery

The WDFW is conducting a review of the current methodologies and alternative methodologies for estimating the incidental handle of steelhead in the commercial fishery. A preliminary review was completed by a WDFW biometrician using data collected from the 2002 commercial fishery. Steelhead catch estimates made by this alternative method were similar to those previously provided by the WDFW/ODFW fishery management staff. The alternative methodology provided handle estimates of 24,250 (95% C.I. = 20,849 – 28,838) total steelhead and 14,581 (95% C.I. = 11,443 – 17,723) wild steelhead. The joint staff methodology provided estimates of 20,854 (95% C.I. = 15,934 – 25,587) total steelhead and 10,020 (95% C.I. = 7,690 – 12,349) wild steelhead. These results suggest that the alternative methodology did not substantially alter the estimates previously produced by the joint staff. The retrospective analysis of the 2002 fishery should be expanded to the 2003 and 2004 fisheries to develop a proposed monitoring and evaluation procedure for future fisheries. The results of this analysis and review will be presented to the *U.S. v Oregon* Technical Advisory Committee (TAC). A summary report is in progress (Cheng *in progress*) and will be used for management of future fisheries.

In addition to comparing handle estimation methodologies, the WDFW biometrician also evaluated the effects of other variables on the accuracy of the steelhead handle estimates. The variables evaluated included: 1) total chinook catch, 2) day *vs*. night fishing periods 3) week, and 4) fishing zone. Of the four variables evaluated only fishing zone affected steelhead handle estimates, and fishing zone was only marginally correlated to steelhead handle (P=0.08). Results of the review indicated stratifying data by day *vs*. night or by week would have no significant impact on steelhead handle estimates. Sample size would be the overriding concern when determining if data should be stratified by zone.

The WDFW biometrician did not evaluate the effect of multiple encounters of steelhead; however, the *U.S v Oregon* TAC has evaluated the impact of this variable during previous discussions regarding this fishery. In past analysis, the TAC concluded that multiple encounters are likely occurring, but the impact on the number of steelhead mortalities would be negligible. The TAC concluded that if multiple encounters were occurring that it would increase post release mortality rates but would reduce the total number of wild steelhead handled in the fishery. The result of these two effects would result in similar mortality estimates for wild winter steelhead. Management of the fishery could benefit from a study that accurately estimates multiple encounter rates for steelhead and the impact of multiple handles on post release survival rates.

5. Estimating Impacts for Individual ESUs:

Estimating steelhead handle by ESU is a difficult and complicated task. Although it is possible to use run timing to separate summer and winter steelhead in tributaries, it is less simple to identify summer and winter steelhead when both may be caught in fisheries. Among winter steelhead, a mixed stock genetics analysis or a mark/recapture study are likely the only methods available to separate wild winter steelhead from the four Columbia Basin ESUs in the fisheries.

Full accounting of abundance by ESUs would be required to fully understand the impacts to individual ESUs. TAC completed a run reconstruction analysis for late summer steelhead several years ago when steelhead in the Columbia River was first listed under the ESA. A complex run reconstruction methodology was established which used dam counts and escapements to estimate river mouth returns of steelhead by ESU; however, a number of weaknesses with this methodology were acknowledged, including the fact that accountability of steelhead in the Columbia River was incomplete. Total spawning escapements are not known for some tributaries. Efforts to identify steelhead stocks in fisheries by run timing or size has been problematic primarily because these phenotypes are not unique to any single populations or ESUs. Some tributary fisheries, such as in the Deschutes, may be catching "stray" steelhead from other ESUs.

At this time, until a better understanding of ESU-specific impacts can be determined, the states propose to manage the spring fisheries on the aggregate wild winter steelhead run in the Columbia Basin, including all four ESUs.

6. Zone 6 Fishery Impacts to Winter Steelhead:

The treaty Indian fisheries in Zone 6 operate under different ESA guidelines than state-managed fisheries. Although the treaty fishery impacts are separate from the non-Indian impacts, an analysis of Zone 6 impacts to wild winter steelhead and their cumulative effect on an increased impact rate in non-Indian fisheries is appropriate. The treaty fishery harvests wild winter steelhead during their winter and spring season fisheries. Since 1996, the treaty fishery catch of steelhead has been reduced due to low prices paid for steelhead and a shift towards sturgeon as a target species during the winter season. From 1995-1999, the proportion of the steelhead catch that was estimated to be winter

steelhead ranged from 0.7% - 12.2%, and the harvest of wild winter steelhead during that same time period is estimated to be from 5 to 42 fish. The Zone 6 fishery only impacts the winter steelhead populations that pass above Bonneville Dam. These include a few populations in the Lower Columbia ESU (such as the Wind and Hood river populations) and the populations in the Mid-Columbia ESU. Although information is not available for recent years, the impact of the treaty Indian fishery on wild winter steelhead appears to be minor, and should not affect the analysis of impact rates in the non-Indian fisheries.

7. Summer steelhead:

Currently our impact models assume that the proportion of wild summer steelhead in the commercial fishery gradually increases fom 5% to 25% over the time frame that the fishery occurs. A more precise estimate of the summer steelhead proportion could be derived from a comparison of timing differences between summer and winter steelhead in the tributaries. Figure 18 illustrates the cumulative percentage of wild winter and wild summer steelhead returning to the Kalama River. The differences in run-timing between wild winter and wild summer runs are apparent. Based on the five-year average run timing proportions, less then 1% of the wild summer run have returned to the Kalama River trap during the month of March. Wild winter steelhead returns are considerably greater, increasing from 25% to 75% of the run returning during the month of March. The percent of wild winter steelhead in the Kalama River trap during the month of March is 99.1%, with the remaining 0.9% of the wild steelhead being summer-run.

The relative entry of winter and summer steelhead into the Hood River during the winter steelhead run (November through June) is shown in Figures 12 and 19. Hood River summer steelhead are present year-round, but at low proportions during much of the winter steelhead run. They increase in numbers both at the Powerdale Dam, and apparently at Bonneville Dam (Figure 12), in early May (Figure 19). The Hood River results are consistent with the Kalama results.

For purposes of this evaluation, the states will recommend that a range of 1%-5% be used for the percent of wild summer steelhead handled in the non-Indian commercial fishery. Although this Biological Assessment is intended to address impacts to ESA-listed winter steelhead, it is important to note that any wild summer steelhead that are incidentally caught in the commercial fishery are also listed under the ESA. It is generally believed that most early wild summer steelhead belong to the Lower Columbia ESU, although early-running fish are present in the Mid-Columbia ESU. Currently wild summer steelhead are subtracted from the catch when impacts are calculated for wild winter steelhead. Impacts to wild summer steelhead occurring during the winter fishery are included in the summer season fisheries. Allowable impact rates for wild summer steelhead are currently 2%.
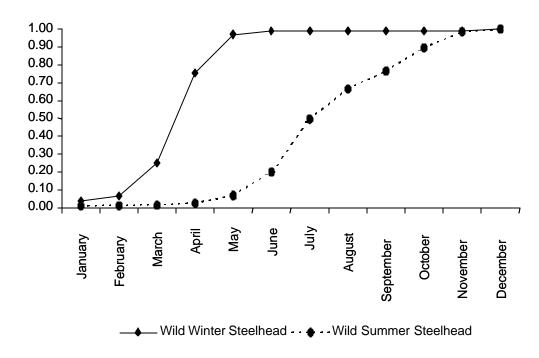
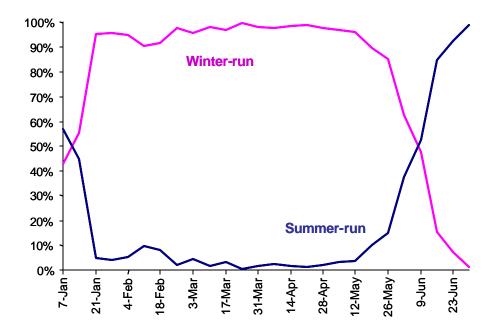Figure 18. Five-year average run-timing proportions of Kalama River wild steelhead.

Figure 19. Relative proportions of the steelhead per day passing Powerdale Dam on the Hood River that are wild winter-run and wild summer-run steelhead.

Additional Management Actions:

At a September 2004 Compact hearing, the states announced their intent to use 9-inch minimum mesh instead of 8-inch minimum mesh for the large mesh portion of the 2005 spring commercial fishery. Information from past monitoring has shown that both mesh sizes work well for reducing steelhead handle; however, the 9-inch mesh should reduce steelhead handle to a greater degree than the 8-inch mesh. Results from a study that was conducted in the treaty Indian fall commercial fishery showed that "mesh-specific differences in steelhead and chinook catch rates significantly reduced numbers of steelhead caught per chinook caught as mesh size increased" and "catch rates of steelhead were consistently and significantly less in 9-inch nets than in 8-inch nets during the 2000 studies" (Beamesderfer and Parker 2001). This action by the Columbia River Compact was specific to 2005 fisheries, and the commercial fishing representatives prefer to leave the 8-inch mesh as an option for future fisheries.

Another tool for potentially reducing steelhead handle in the commercial fishery is the use of a steelhead excluder. A steelhead excluder is a panel of large mesh (12-inch minimum) net or no mesh at the top 5 to 10 feet of the tangle net. The theory is that steelhead may be surface oriented and thus pass through the net completely. Preliminary information suggests that nets with the excluder may handle fewer steelhead than the regular tangle nets; however, a study designed specifically to test the effect of the excluder panel on steelhead and chinook catch rates has not been completed at this time. About 5-10% of the fleet voluntarily uses the steelhead excluder at this time (North 2004).

Conclusions

The states are proposing that NOAA Fisheries make a no-jeopardy determination and consider granting approval under the ESA for a wild winter steelhead harvest impact rate up to 6% for 2005. In doing so, the states recognize that this impact rate would be applied to an aggregate of wild winter steelhead in the Columbia Basin, and that wild winter steelhead are distributed across four ESUs, each of which are composed of multiple populations, some of which are in stronger and some in weaker status condition. The states believe that the three listed ESUs would not be placed in jeopardy if they are managed for an impact rate up to 6% for the period of one year, but we recognize that this rate may pose higher risks to some populations than to others.

In support of this proposal, the states conclude:

1. Populations in the listed ESUs vary in the strength of their status; however, most populations for which there is information are currently at elevated abundances, most probably associated with favorable ocean conditions;
2. The age structure of steelhead is variable and overlapping which protects weaker populations from potential risks caused by a one-year increase in impact rate;

3. The overall risk to recovery or rebuilding of wild winter steelhead populations as a result of increasing the impact rate from 2% to 6% for 2005 is negligible.
4. Given the anticipated elevated abundances and mitigating effect of multiple age classes, it would be appropriate to manage for a 6% impact rate of the aggregate Columbia River wild winter steelhead run in 2005;
5. Although run timing differences exist between ESUs and among populations within ESUs when measured in the tributaries, the weight of current evidence suggests those differences would likely not result in different vulnerabilities in mainstem fisheries;
6. Valid methods are available for making pre-season abundance forecasts. A forecast for 2005 will be made by the TAC, taking these available methods into consideration;
7. The current method for estimating steelhead handle in the commercial fishery is valid;
8. The contribution of wild summer steelhead in the fishery is low;
9. Impacts from the treaty Indian fishery on wild winter steelhead are low and specific to populations that return to tributaries above Bonneville Dam;
10. A further review of stock status and a risk assessment will be completed prior to the 2006 fishery;
11. The proposed fisheries and increased impacts address the statutory obligation and authority of the states of Oregon and Washington to provide for harvest opportunity when the situation exists. The economic and social benefits of the proposed fisheries are critical to affected non-Indian fishers, specifically the commercial fishing industry.

In making this proposal for an increased impact rate up to 6% for 2005, the states recognize that there is some level of uncertainty in the management of commercial fishery impacts on wild winter steelhead. As stated above, the states propose that prior to the 2006 fisheries a detailed analysis be conducted of wild winter steelhead status, and commercial spring chinook fisheries risks to steelhead. The states also propose to investigate the concept of a sliding scale impact rate that would be associated with wild winter steelhead stock status and marine survival, and to investigate weak-stock management approaches. The states recognize that this analysis may result in changes to recommended impact rates, monitoring protocols, and impact modeling.

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